

## THE XYLONOVA HYBRID FIELD TRIALS: CLONALLY REPLICATED FAMILY TRIALS FOR VERIFICATION OF QTL ANALYSIS AND HYBRID TESTING.

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### ABSTRACT

The XYLONOVA Syndicated Research and Development Program is focused on developing salt tolerant hybrids for establishing commercial plantations on saline, waterlogged and degraded land. During the initial phases of the program, novel hybrids between *Eucalyptus camaldulensis* x *E. grandis* (6 families) and *E. camaldulensis* x *E. globulus* (4 families) were developed. The aim was to combine the salt tolerance of *E. camaldulensis* with the growth rate and wood quality traits of *E. grandis* and *E. globulus*. The family structures were designed to enable genetic mapping and QTL analysis. An essential component of the XYLONOVA program is to test these hybrids under conditions representative of areas where development of forestry on saline lands is likely. Two clonally replicated field trials testing the hybrids have been established in the southern Murray-Darling Basin. In 1998, a preliminary trial was established at Mt Scobie, near Kyabram (northern Victoria). It comprises 217 genotypes from 2 *E. camaldulensis* x *grandis* families and 4 *E. camaldulensis* x *globulus* families. This trial is a single tree plot, incomplete block design with 5 replicates and a single irrigation treatment using pumped saline groundwater. In 1999, a larger trial was established at Caldwell, near Deniliquin (southern NSW). This trial tests 591 genotypes from all 10 families. It is a single tree plot, incomplete block design, with 5 replicates and 2 irrigation treatments. A large demonstration block of 3-tree plots of all available genotypes of each family and 25-tree mono-clonal plots of selected clones was also established. This block will demonstrate the growth of the hybrid clones and families compared to each other and their parental species. The field trials provide the opportunity to verify QTL analysis of glasshouse salt tolerance screening trials, and evaluate the usefulness of glasshouse screening for early selection of field salt tolerance. They will also allow examination of clonal responses to salinity, and the development of silvicultural practices for these hybrids.

### INTRODUCTION

The XYLONOVA Syndicated Research and Development Program aims to develop novel eucalypt hybrids for establishing commercial plantations on saline, waterlogged and polluted land, initially in the Murray-Darling Basin. During the initial phases of the XYLONOVA R&D Program, hybrids between *Eucalyptus camaldulensis* x *E. grandis* and *E. camaldulensis* x *E. globulus* were developed with the aim of combining the salt tolerance of *E. camaldulensis* with the growth rate and wood quality traits of *E. grandis* and *E. globulus*. An essential component of the overall XYLONOVA program is to test these hybrids in the field under conditions representative of areas where development of forestry on saline lands is likely. Two clonally replicated field trials testing the hybrids have been established in the southern Murray-Darling Basin. The first was a preliminary trial planted at Mt Scobie (near Kyabram, northern Victoria), which included 2 to 5 ramets of 217 genotypes from 6 of the 10 XYLONOVA hybrid families. A second, larger field trial was established in October 1999 at

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“Thornton”, a property between Deniliquin and Barham in southern New South Wales. This trial tests all 10 hybrid families (591 genotypes with 2 to 5 ramets in each treatment) in a specifically designed experiment which includes different salinity treatments in the irrigation. Within each trial, related pure species controls (seedlings and clones) are included. The two trial sites provide the opportunity to verify quantitative trait locus (QTL) analysis undertaken in earlier parts of the XYLONOVA R&D Program. The trials at “Thornton” also include a large demonstration block that will provide an opportunity to demonstrate the growth of the hybrid clones and families compared to each other and their parental species.

### Family structures

Two types of hybrids were produced - *E. camaldulensis* x *E. grandis* (6 families) and *E. camaldulensis* x *E. globulus* (4 families). The inter-related family structures were designed to provide a mixture of full-sib families and half-sib arrays for genome mapping and marker assisted selection (Dale and Chaparro 1996). Tables 1a and 1b show the family structures and their representation at each trial site.

**Table 1a:** Family representation at Mt Scobie (1998). Numbers in brackets indicate the number of genotypes per family represented in the field trial.

		<i>Eucalyptus grandis</i> fathers		<i>Eucalyptus globulus</i> fathers		
		<b>E. gr 1</b>	<b>E. gr 2</b>	<b>E. gl 1</b>	<b>E. gl 2</b>	<b>E. gl 3</b>
<i>Eucalyptus camaldulensis</i> mothers	<b>E. cam 1</b>			* (24)		* (11)
	<b>E. cam 2</b>			* (34)	* (4)	
	<b>E. cam 3</b>	* (73)	* (71)			
		<i>E. camaldulensis</i> x <i>E. grandis</i> : 144 genotypes		<i>E. camaldulensis</i> x <i>E. globulus</i> : 73 genotypes		

**Table 1b:** Family representation at “Thornton” (1999). Numbers in brackets indicate the number of genotypes per family represented in the field trial.

		<i>Eucalyptus grandis</i> fathers		<i>Eucalyptus globulus</i> fathers		
		<b>E. gr 1</b>	<b>E. gr 2</b>	<b>E. gl 1</b>	<b>E. gl 2</b>	<b>E. gl 3</b>
<i>Eucalyptus camaldulensis</i> mothers	<b>E. cam 1</b>	* (41)	* (20)	* (14)		* (5)
	<b>E. cam 2</b>	* (26)	* (45)	* (45)	* (4)	
	<b>E. cam 3</b>	* (215)	* (176)			
		<i>E. camaldulensis</i> x <i>E. grandis</i> : 523 genotypes		<i>E. camaldulensis</i> x <i>E. globulus</i> : 68 genotypes		

### Site Descriptions

Mt Scobie is located approximately 11 km west of Kyabram, in the Northern Irrigation Region of Victoria. The XYLONOVA field trial is nested within a salt-tolerant species-provenance trial established by the Institute of Sustainable Irrigated Agriculture. The site forms part of a salinity control experiment testing conjunctive water use as a form of integrated on-farm salt management. The trial is located within the draw-down zone of a groundwater pump, and is used to dispose of the saline water extracted by the pump. Irrigation with low salinity water continues on surrounding dairy pasture. The trees are located in an area which had become too saline for continued pasture production, with soil salinity of approximately 8 dS m<sup>-1</sup> (EC<sub>1:5</sub>). The predominant soil type in the trial area (Skene

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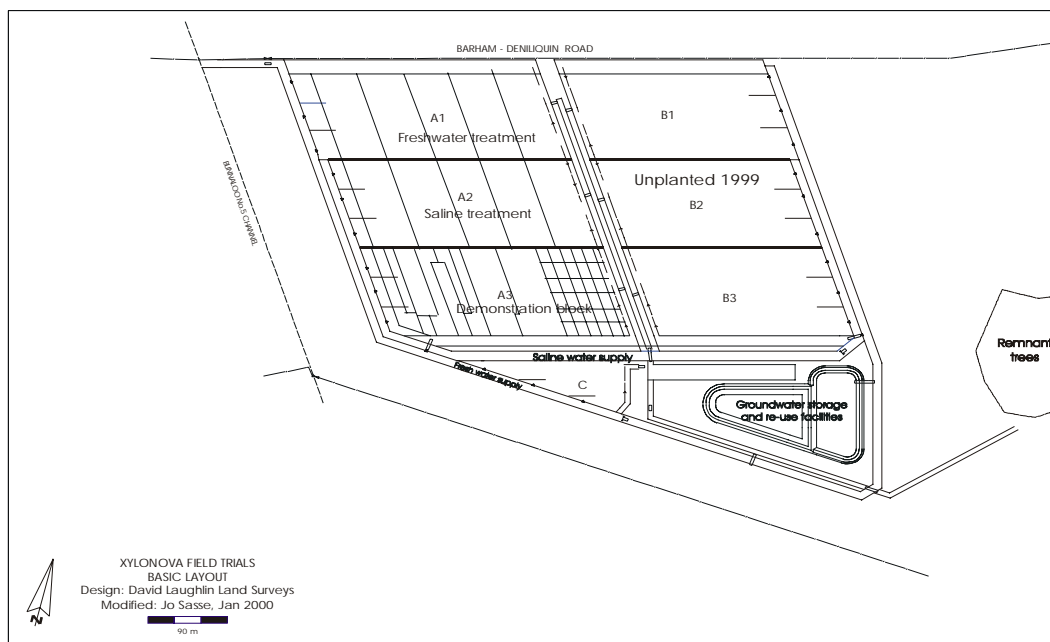
and Poutsma 1962) is a Goulburn Loam (a grey-brown loam from 0-12 cm, with a subsoil of yellowish-brown medium to heavy clay). A tongue of Congupna Clay (grey, gilgaied clay of less than 10 cm, with a heavy clay subsoil) across the bottom of the trial associated with a drainage line. Mean annual rainfall in the area (Kyabram) is approximately 465 mm, and mean annual evaporation is about 1606 mm.

“Thornton” is located approximately 50 km west of Deniliquin, in southern NSW. The trial is on a site with high water tables and saline, sodic soils. The predominant soil association type (Johnston 1952) in the trial area is described as a Riverina Clay (a non self-mulching clay with a sandy clay loam crust and brown to grey heavy clay subsoil). Prior streams cross the trial site and these areas are characterised by lighter textured, more permeable soils. The soil is sodic (ESP > 15 in B-horizon) and saline at depth (>5 dS m<sup>-1</sup> EC<sub>1.5</sub>). A saline (>10 dS m<sup>-1</sup>) water table is present between 2 - 4 m depth. Mean annual rainfall in the district (Deniliquin) is approximately 409 mm, and mean annual evaporation is about 1789 mm.

### Trial Designs

Both trials are incomplete block designs with single tree plots and 5 replicates per treatment. The replicates account for any potential gradient in watering from the surface irrigation design employed where the lower part of the bay may receive more water than the higher part of the bay. Replicates at Mt Scobie comprise 208 trees, and the trial has a single irrigation regime (fresh water in year 1; ~5 dS m<sup>-1</sup> in year 2 and ~10 dS m<sup>-1</sup> from year 3 onwards). Replicates at “Thornton” contain 600 trees, and this trial has two irrigation treatments in separate bays (Figure 1). In the establishment year, both bays will be irrigated with fresh water, but from year 2 onwards, different treatments (expected to be saline and fresh water irrigation) will be applied.

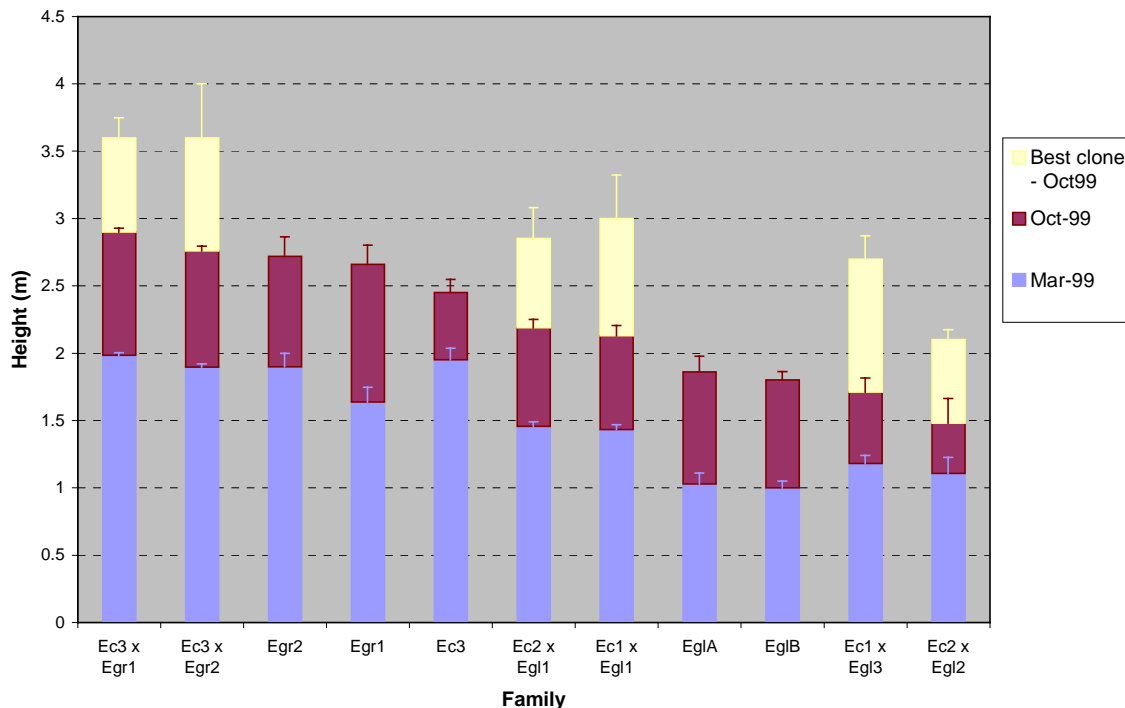
**Figure 1:** Schematic diagram showing layout of the 1999 “Thornton” field trial



## EARLY RESULTS

Tree growth at both sites is being monitored closely. Early growth at Mt Scobie has been rapid, with significant differences between families and genotypes (Figure 2). The effects of saline irrigation are currently being monitored.

**Figure 2:** First-year height growth by family at Mt Scobie, showing mean height and standard error by family at March and October 1999, and the best clone within each family at October 1999.



## CONCLUSIONS

The XYLONOVA field trials provide clonally replicated family trials specifically designed for verification of QTL analysis and hybrid testing. These trials can contribute to developing and verifying marker assisted selection techniques, which could then be applied to conventional breeding programs in Australia and elsewhere to more rapidly achieve genetic gain. In particular, marker assisted selection could be applied in second generation backcross hybrids where it may be possible to reduce the representation of *E. camaldulensis* in the genetic background of the hybrid, while maintaining desirable genes for salt tolerance from this parent. This will be a particularly useful tool for a complex trait such as salt tolerance which comprises multiple physiological mechanisms, each of which are believed to be under varying levels of genetic control (Frommer et al. 1999; Lambert and Turner, in press; Niknam and McComb, in press). These trials will also provide the opportunity to assess the usefulness of glasshouse pot trials for screening of field salt tolerance. While glasshouse trials have been widely used for this purpose, detailed correlations of clonal families between glasshouse and field trials have not previously been carried out (Niknam and McComb, in press).

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